Atmospheric Composition and Climate Program (ACCP)

Information Sheet FY2009

General Objectives of the Program

The Atmospheric Composition and Climate Program element (ACCP) pursues two overall research objectives: (i) to improve the predictive understanding of the radiative forcing of the climate system by aerosols and chemically active greenhouse gases, and (ii) to better characterize the recovery of the stratospheric ozone layer, including its role in climate change. The integrated research activities that address these objectives involve instrument development, regional-to-global observations, laboratory studies, and theoretical modeling by NOAA and extramural partners. A hallmark of the program is that its objectives are cooperatively framed with both national and international collaborators. For example, NASA, NSF, DOE, and NOAA co-plan and execute collaborative/coordinated field studies. Further, frameworks exist to facilitate this cooperation: (i) from an organizational perspective, e.g., the CCSP/USGCRP Atmospheric Composition interagency subgroup, which NOAA and EPA co-chair; and (ii) via international coordination, e.g., the International Global Atmospheric Chemistry (IGAC) and Stratospheric Processes and their Role in Climate (SPARC) programs.

Contributions to NOAA's Climate Mission Goal

Within NOAA's Climate Mission Goal lie three Programs, each tasked to a subgoal, including the Climate Research and Modeling Program (CRM) [NOAA, 2008], of which ACCP is an element. The objective of CRM is to reduce uncertainty in the information on atmospheric composition and feedbacks that contribute to changes in Earth's climate. Within CRM, ACCP supports basic scientific research into atmospheric composition-related processes and mechanisms controlling global climate. The emphasis on increasing predictive knowledge of the climate system is one of ACCP's key contributions to NOAA's climate research portfolio. Understanding not just the current status of the Earth's climate system, but also its potential responses to changing conditions, can be achieved only through identifying and understanding the dominant factors influencing climate. Predictive knowledge is vital to informing and improving predictive climate models, and ultimately providing the information necessary for stakeholders to make climate-relevant decisions.

FY 2009 Focus

ACCP will give specific attention to advancing understanding of the interactions of aerosols with the global climate system and understanding of the role of water vapor in the upper troposphere and lower stratosphere (UT/LS).

Aerosols play key roles in the Earth's climate system. However, crucial aspects of these roles remain poorly quantified. Several of the fundamental characteristics of aerosols make understanding their impacts on climate challenging:

- short residence times in the atmosphere;

- consequent high temporal and spatial variability;
- broad ranges of origins and compositions;
- physical and chemical complexity, often a function of age;
- reactivity in the atmosphere; and
- a diverse suite of effects on the climate system, including interactions with clouds.

Two overarching needs associated with a better understanding of the climatic roles of aerosols are (i) an observationally-based regional climatology of aerosols ("what's out there and how is it changing?"), and (ii) a predictive understanding of the processes linking emission sources to spatial and temporal distributions, chemical composition, and radiative properties of anthropogenic and natural aerosols ("why is it changing?"). Intensive field campaigns, such as those listed in this announcement (VOCALS, ACRPAC and ICEALOT, listed below), are one way to address these needs and are essential for evaluating and improving global aerosol observations from the ground, air, and space. Overall, the goal is to improve radiative and climate models and assess their uncertainties, which, in turn, are the only tools that can yield estimated simulations of societal-needed "if, then" decision-support scenarios.

In addition to aerosols, improving our understanding of water vapor in the upper troposphere and lower stratosphere (UT/LS) is a new priority for a number of reasons. Water vapor in the UT/LS is interconnected to multiple climate forcing factors (cirrus clouds, aerosols, ozone, and abundances of other climate gases), and the influence of water vapor must be accounted for to accurately calculate the climate forcing by each of the other forcing agents. A large portion of the water vapor feedback in the climate system comes from water loading in the UT [Held and Soden, 2000]. There are a number of areas related to water vapor in the UT/LS with large uncertainties in our understanding, for example the super-saturation of water vapor over ice in cold regions of the UT/LS that affects our ability to accurately assess trends in long-term balloon measurements of water vapor. The commercial aircraft fleet emits both particulates and water vapor as part of combustion exhaust directly into the UT; the impacts of these sources require a solid understanding of the distribution of super-saturation at aircraft flight levels, which we do not have at this time. Lastly, long-term trends in water vapor are needed to better understand its role as a climate-forcing agent, so research related to accurate water vapor measurements are essential, both for *in-situ* and remote sensing (satellite) measurements. The importance of water vapor in the UT/LS is signified by the fact that the radiative contribution of the UT/LS water vapor is now explicitly recognized in the IPCC Fourth Assessment Report (AR4) [IPCC, 2007]. For all of these reasons, water vapor in the UT/LS has been identified as a research priority for ACCP this year.

ACCP will concentrate on five focus areas. Attention will be given to proposals illustrating a direct link from the proposed research to the desired outcomes listed below.

1. Data analysis and/or modeling related to the VOCALS field campaign from 2008 (http://www.eol.ucar.edu/projects/vocals/)

The VAMOS Ocean-Cloud-Atmosphere-Land Study (VOCALS) addresses the need for better scientific understanding of the tightly coupled land-ocean-atmosphere system of the Southeast Pacific (SEP). The need to better understand this complex and important component of the global climate system is reflected in the repeated failure of coupled ocean-atmosphere models to accurately represent tropical rainfall, sea surface temperature, and winds on seasonal and longer time scales in the SEP. VOCALS is an interagency-international field campaign and modeling study endorsed by several climate research organizations (including WCRP, CLIVAR, VAMOS, and GEWEX) and supported in the United States by NSF and NOAA.

The field campaign portion (VOCALS-REx) is set to take place in October 2008. ACCP is interested in supporting proposals that involve analysis of field data from VOCALS-REx and/or proposals that involve modeling work as part of the modeling portion of the study (VOCALS-Mod). Of particular interest to ACCP is the role of the SEP stratocumulus cloud deck in the regional and global climate system, and how regional aerosols may affect its climate impacts.

2. Data analysis and/or modeling related to the ARCPAC (http://www.esrl.noaa.gov/csd/arcpac/) and ICEALOT (http://saga.pmel.noaa.gov/Field/icealot/) field campaigns from 2008

The Aerosol, Radiation, and Cloud Processes affecting Arctic Climate (ARCPAC) and International Chemistry Experiment in the Arctic LOwer Troposphere (ICEALOT) field projects that were led by NOAA in 2008 as part of the International Polar Year (IPY) sought to elucidate the role of aerosols, particularly absorbing aerosols, in the Arctic climate system. The ARCPAC campaign took place in April 2008 and involved the deployment of the NOAA WP-3D platform in Fairbanks, Alaska. The ICEALOT campaign involved the deployment of the research vessel *Knorr* in the ice-free region of the North Atlantic in March and April of 2008. The scientific issues addressed as part of both campaigns include springtime sources and transport of pollutants to the Arctic, evolution of aerosols and gases into and within the Arctic, and climate impacts of haze and ozone in the Arctic.

ACCP is interested in supporting proposals that involve analysis of field data from either ARCPAC or ICEALOT and/or proposals that involve modeling work related to these campaigns. ACCP is particularly interested in those projects aimed at further understanding the role of absorbing aerosols in the Arctic climate system.

3. Preparation for and participation in the proposed CalNex field campaign in California in 2010 (http://www.arb.ca.gov/research/fieldstudy2010/fieldstudy2010.htm)

The National Oceanic and Atmospheric Administration (NOAA), the California Air Resources Board (CARB), and the California Energy Commission (CEC) are proposing a joint field study of atmospheric processes over California and the eastern Pacific coastal region in 2010. Referred to as "CalNex" (for "California Nexus"), this study will emphasize the interaction between air quality and climate change issues, including those affecting the hydrologic cycle. This multi-agency study will bring together specialized, complementary resources such that the outcome will be able to answer important scientific questions that have an impact on environmental policy, e.g., evaluating policies that are "win-win" for both air quality and climate change.

ACCP is interested in supporting field measurement projects for participation in the CalNex campaign. Particular attention will be given to those projects that require time for instrument development in advance of the campaign in 2010.

4. Research pertaining to the improvement of our understanding of processes governing water vapor in the upper troposphere and lower stratosphere

Water vapor in the upper troposphere and lower stratosphere (UT/LS) is a major uncertainty in the climate system. Water vapor in the UT/LS is interconnected to multiple climate forcing factors, e.g., cirrus clouds, aerosols, ozone, and abundances of other climate gases. As discussed above, examples of areas of current research related to water vapor in the UT/LS that still have large uncertainties are water vapor transport in the UT, feedbacks on water vapor in a changing climate, limits of super-saturation with respect to ice at cold temperatures, measurement accuracy of water vapor, actual distributions of super-saturation at commercial aircraft flight level, effects of aircraft engine emissions on UT cloud distributions, and long-term changes in water vapor concentrations.

ACCP is interested in supporting projects that seek to improve our understanding of processes related to water vapor in the UT/LS. Particular attention will be given to innovative projects and those seeking to elucidate mechanisms for water vapor transport in the UT, diagnose change and variability in distributions and concentrations of UT water vapor, and evaluate the effects of those changes on other climate forcing factors.

5. Innovative research pertaining to the improvement of understanding of aerosol-cloud-climate interactions, through studies targeting processes or measurements related to atmospheric composition or studies aimed at improving the capability of climate models to simulate the influence of aerosol effects on the Earth's radiative balance

The principal research focus for ACCP in previous years has been on contributing to a better understanding of the processes by which aerosols change the radiative balance of the atmosphere, with an emphasis on aerosol/cloud/climate interactions. The uncertainty associated with the influence of aerosols on climate remains the dominant uncertainty in radiative forcing [IPCC, 2007; CCSP, 2003]. Therefore, a better characterization of the effects of natural and anthropogenic aerosols on the radiative balance of the atmosphere is crucial for a more accurate prediction of the impact of human activities on climate, and vice-versa [CCSP, 2003].

ACCP is interested in supporting significantly innovative proposals that seek to further understand aerosol/cloud/climate interactions, particularly those that support a direct flow of knowledge from process-level research into improved climate model performance.

Please note that these focus areas are not necessarily separate entities. Proposals that aim to address more than one focus area will receive particular attention.

References

CCSP, July 2003. Strategic Plan for the Climate Change Science Program (available online at http://www.climatescience.gov/Library/stratplan2003/default.htm). See Chapters 1 through 3.

Held, I.M. and B.J. Soden, 2000, Water vapor feedback and global warming, Annual Review of Energy and the Environment 25: 441-475.

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NOAA, 2008. http://www.climate.noaa.gov/index.jsp?pg=./cp_cf/description.html

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